Abstracts

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Geothermal Fields and Plate Tectonics in Circum-Pacific Area

A number of geothermal fields explored so far in the Circum-Pacific area occur along spreading ridges and subduction zones in areas of young tectonism and volcanism. A preliminary analysis by pattern recognition techniques, however, suggests that these geothermal fields are not situated along entire segments of plate boundaries but only at certain locations. These locations are (1) near the ends of plate boundary segments or (2) near sharp bends in the trench systems or (3) in transverse zones which divide plates into several blocks 62 to 620 mi (100 to 1,000 km) long. The locations of geothermal fields, therefore, appear to be influenced by plate geometry and correspond to lateral breaks in the continuity of the underthrusting plate. Shear heating in these transverse zones, which separate different blocks in a plate boundary, may explain the excess heat flow which allows the development of geothermal fields in these zones. In divergent zones, the geothermal fields are situated near where the spreading systems are offset by transform faults. Exploration for geothermal fields is on a haphazard basis at present, guided primarily by the presence of hot springs and fumeroles. This study will help in the development of geothermal energy by identifying broad zones in which exploration should be carried out and by providing a hypothesis for their occurrence.

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Geochemistry of Manganese Deposits of Nicoya Ophiolite Complex in Costa Rica

Numerous small Mn deposits have been reported from the Nicoya ophiolite complex in Costa Rica. These deposits are primarily of two types: (1) deposits occurring in radiolarites consisting of laminar units of alternating radiolarite and Mn-oxide and overlying Mn-crusts which grade into nodular concretions, and (2) deposits occurring as stockworks of veins of Mn-oxides within silica lenses (up to 16 × 328 ft, 5 × 100 m) in basalt. The two types occur in different nappe units of Lower and Upper Cretaceous ages.

Geochemical and X-ray analyses of the deposits indicate the following: (a) they show low Ni, Co, and Cu (total $<0.5\%$) and low Fe/Mn ratio (<0.1) like the Mid-Atlantic Ridge deposits; (b) Fe/Mn in a few basaltic deposits ranges from 0.1 to 0.9; (c) concentrations of rare earth elements (REE) and the shale normalized REE patterns of the deposits are similar to those found in tholeiitic basalt; (d) absence of Ce enrichment is commonly observed in manganese nodules; (e) higher REE and Cu and lower Si occur in nodular concretions than in other radiolarian deposits; and (f) braunite and pyrolusite as predominant minerals.

These facts, along with other geologic evidence, suggest that the Mn deposits are hydrothermal precipitations and are related to sea-floor spreading processes during Cretaceous time. The laminar units were formed as the fractionated Mn-rich hydrothermal solutions passed through the radiolarian oozes. The crust was formed directly above the main emanation centers and the nodular concretions possibly grew away from the source. Basaltic deposits were formed at various stages of fractionation of the hydrothermal solutions, resulting in deposits of varying chemistry.

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Compressed Air Energy Storage for Electricity Generation

Electric utilities attempt to meet fluctuating demands for power at lowest cost and with least consumption of premium fuel. Base-load coal and nuclear plants are designed to supply about 50% of maximum load. The remaining load is supplied by less efficient cycling generators which burn natural gas, petroleum, or coal.

The compressed air energy storage (CAES) method reversibly converts electrical energy to mechanical energy. Air compressed with excess base-load capacity during off-peak periods is stored within an excavated geologic cavern or water-bearing porous rock formation. During peak-load periods, compressed air is released, mixed with fuel, burned, and expanded through turbines to generate power. CAES reduces conventional peaking plan consumption of petroleum by over 60%. Advanced conceptual plants could eliminate petroleum consumption by either (1) storing the heat of compression to reheat the compressed air, or (2) passing the compressed air through a pressurized fluidized coal-bed combustion chamber. CAES provides flexibility, frequency control, rapid start-up, and smaller impact on the environment than cycling plants.

In California, potentially favorable geologic sites for CAES exist in depleted gas fields, depleted oil fields, saline aquifers, and hard rock formations. Economic benefit was evaluated using sensitivity analysis to identify how various parameters affect the bus-bar cost of electricity. Feasibility also depends upon the power generation cycle, experimental proof of operations in aquifer reservoirs, and institutional and legal clearances. The future potential for CAES is discussed with respect to the geology and population distributions of the Circum-Pacific region.

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Worldwide Applications of Ground-Coupled Heat Pumps, Conventional and Solar Assisted

The use of the ground as an energy source, sink or storage element for coupling to a heat pump has attracted renewed interest in recent years. Several system options have been developed, some of which use additional solar-derived energy. In applying ground coupling in a given situation, three major decisions must be made. First, it must be decided whether to use solar energy in the ground-coupled system, and if so, whether to design for long- or short-term energy storage. Second, the type of in-ground heat exchange device must be selected. These include the horizontal coil, the vertical heat exchanger, the buried water tank, and the buried flat plate. Third, the heat-exchange device must be sized relative to the heat pump, the load, and the solar components, if any. The ways in which these decisions have been approached in a variety of countries and climates have been analyzed as a base for assessing the outlook for ground-coupling applications in terms of economic, energy supply, and technology development scenarios which could work for or against ground coupling. These include availability and cost of the various forms of energy, in particular gas versus coal; availability of capital and interest rates; utility load profiles; and technical developments in air-to-air heat pumps, gas furnaces, and gas-fired heat pumps. The paper concludes with a discussion of research and development needs for ground coupling.

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Overview of International Solar Central Receiver Projects

(No abstract)

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Supply of Australian Export Coal—How Much at How Much?

In 1980-81, Australia exported 47.4 million tonnes of coal, split equally between New South Wales and Queensland. Forecasts by the Joint Coal Board for Australian exports in 1990 are in the range 115 to 180 million tonnes, increasing by 2,000 to 180 to 290 million tonnes; 55 to 60% is to come from New South Wales. The World Coal Study forecasts are at the lower end of the range. Will the supply factors allow these forecasts to be achieved?

Australia's measured and indicated recoverable reserves are sufficient to sustain the year 2000 (total) production level for about 70 years. The desire of companies to produce coal is also sufficient to achieve these forecasts. Committed and proposed projects could result in an export productive capacity, by 1990, of 110 million tonnes in Queensland and 80 million in New South Wales. However, port capacity will probably constrain exports to a maximum of 65 million tonnes for each state.

A more severe constraint upon exports will be the cost of the coal FOB port. Although the Australian coal industry has the world's highest output per manshift, wage scales are also very high. More critically, royalties and other government charges, particularly excess rail freight charges, are so high that many prospective mines will probably not be economic.

This prediction is expounded using supply curves for the existing and near term New South Wales and Queensland producers.

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Results of Exploration in Browse Basin, Northwest Shelf, Western Australia

The Browse basin lies entirely offshore beneath the remote northwestern continental shelf of Australia. It occupies an area of approximately 39,000 mi^2 (100,000 km^2), most of which lies in water depths exceeding 650 ft (200 m). The basin originated during the Paleozoic as a broad, intracratonic downwarp, which was considerably modified by tectonism association with continental break up during the Jurassic. After passing through restricted rift-basin and rim-basin phases during Early–Middle Jurassic and Late Jurassic–Early Cretaceous times the basin was opened to oceanic circulation in the Late Cretaceous, when its western margin subsided. Prograding Tertiary shelf carbonates subsequently covered the old basin and formed the present continental shelf.

Exploration of the basin and environs began in 1964 when license areas totaling some 63,000 mi^2 (164,000 km^2) were awarded to the "Northwest Shelf Joint Venture," a consortium of companies presently comprising the Woodside Group, together with Hematite Petroleum, Shell Development Australia, California Asiatic and BP Petroleum Development Australia. During the 11-year period to 1975, some 13,700 mi (22,000 km) of seismic were shot and 11 exploration wells drilled, resulting in the discovery of gas at Scott reef. At the end of the initial permit period some 62% of the total area was relinquished. The remaining permit areas, totaling 24,162 mi^2 (62,579 km^2) were renewed for the first renewal period of 5 years. During this renewal period a further 4,100 mi (6,700 km) of seismic were acquired and 8 wells drilled, resulting in 2 additional gas discoveries (Brecknock and Brewster) and one encouraging oil show (Caswell). In 1980, following statutory relinquishment, remaining permit areas, totaling 10,842 mi^2 (28,083 km^2), were renewed for a further 5-year period.

Initial obstacles to explorlation were water depth and the considerable thickness of multiple-generating Tertiary carbonates covering much of the basin. These have been largely overcome by advances in drilling technology and seismic data processing. Lost circulation zones and geopressured claystone intervals continue to cause problems with drilling.

Geochemical and maturation studies indicate that mature source rocks are present in the central basin, parts of which have been generative since the Late Cretaceous. Structural analysis suggests that the timing of trap formation is favorable with respect to likely hydrocarbon migration throughout much of the central basin, but is less favorable in the north, where a very late phase of structural growth is evident.

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Role of U.S. Geological Survey in Assessment of Conventional Energy Resources in Countries Other than USA

The U.S. Geological Survey has had a program of energy-resource studies in cooperation with counterpart agencies of other countries for many years. The products of the earlier cooperative activities were mainly reports of geologic research conducted to aid exploration and development of energy resources in specific areas such as coalfields or potentially petroliferous basins. In contrast, many of the more recent studies have been wide-ranging evaluations of conventional energy source materials and conditions in the developing countries. These recent studies are largely based on existing information, and attempt to assess the quantity and quality of known energy resources, to evaluate the potential for development of both known and hypothetical resources, and to act as guides for future research and development activities. The studies are made in collaboration with the appropriate agency of the foreign government and are funded by the U.S. Agency for International Development, the U.S. Department of Energy, or, in some cases, by the participating country itself.

The reports that have been produced range from administrative project reports of varying format to U.S. Geological Survey Professional Papers. Comprehensive reports